

North American Electric Traction Drive Supply Chain Analysis: Focus on Motors

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SYNTHESIS PARTNERS, LLC



Overview

Timeline

- Start: October 2014
- End: September 2015
- Percent complete: 50%

Budget

- Total project funding
 - DOE share: 100%
- Funding received in FY14: \$249K
- Funding for FY15: \$252K

Barriers

- Ability of technology supply chain to support plans for increased power electronics (PE) and motors manufacturing in North America (NA).
- Pathways to cost reduction for sustainable and competitive manufacturing and workforce base in traction drive PE and motors in NA.
- Need for accurate information about PE and motors manufacturing capability in North America.

Partners

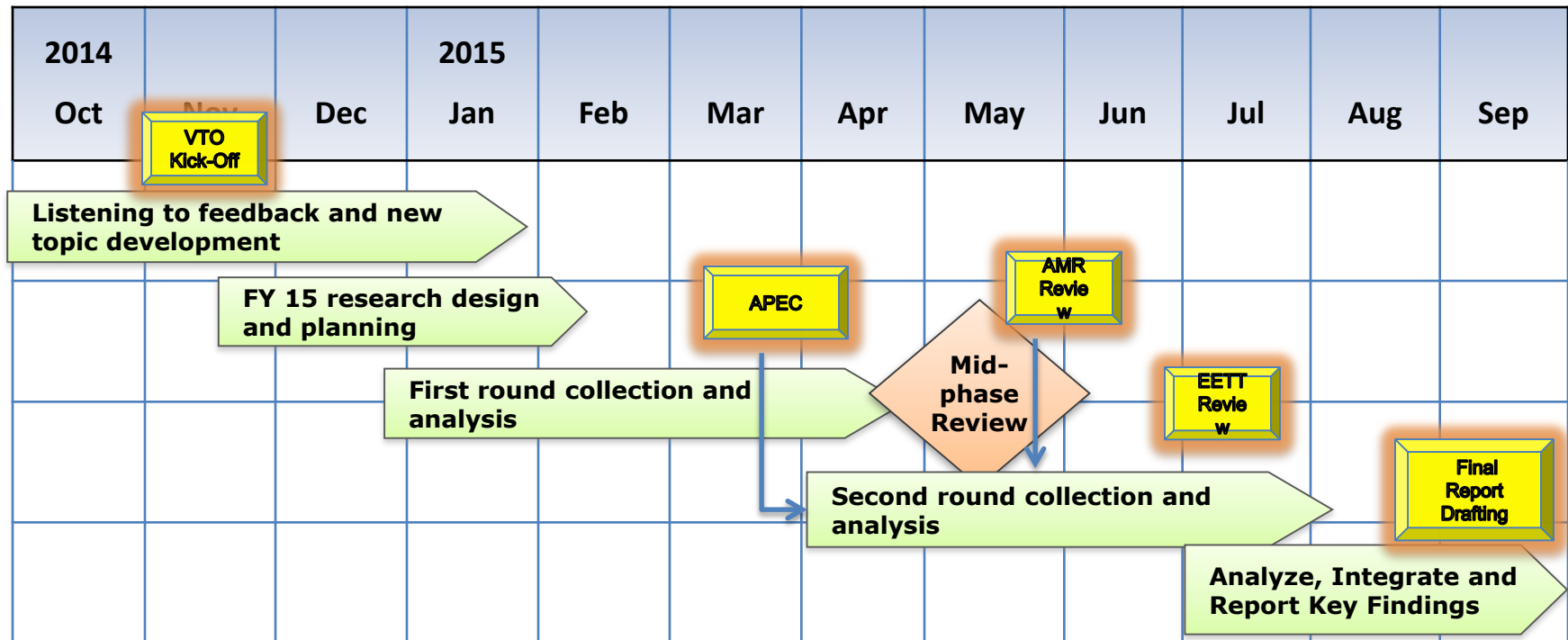
Interactions/ collaborations

- USCAR Electrical and Electronics Tech Team (EETT); OEMs, Tier 1-4s; DOE National Labs.
- Project lead: Synthesis Partners, LLC

Objectives/Relevance

- Targeted collection and analysis of primary and secondary source data to address questions of direct interest to DOE Vehicle Technologies Office (VTO) regarding the North American (NA) electric drive supply chain.
- Custom assessment of anonymized information from 100s of sources on NA power electronics, motors and electric drive vehicle manufacturing capabilities to address VTO questions.
- Identification and tracking of capability gaps that can negatively impact (USG) plans to expand power electronics and electric motors manufacturing capabilities in NA.
- Actionable recommendations to help VTO achieve energy efficiency and renewable energy objectives.

Project Milestones: Challenges/Barriers



Go No/Go Decision Points: Ongoing assessment, mid- and end-of-phase review.

Challenges/Barriers: Time to process and analyze large amounts of heterogeneous data; access to primary sources; navigation to highest-value data via source confidentiality agreements; management of large data-sets; targeted collection from foreign language data assessments.

Key Deliverables: Presentations and concise reports on key findings.

Interim Findings Update

- Focusing on motors supply chain research today.
- Other ongoing work, to be addressed in future briefs and reports:
 - Traction drive power electronics (PE) supply chain gap analysis updates;
 - Targeted research in support of DOE-VTO-led traction drive inverter cost model development activities;
 - Updating reports to be added to our library of NA PE and motors supply chain gap analyses; and
 - Source relationship building and fact-finding in support of DOE-VTO, including potential roundtables.

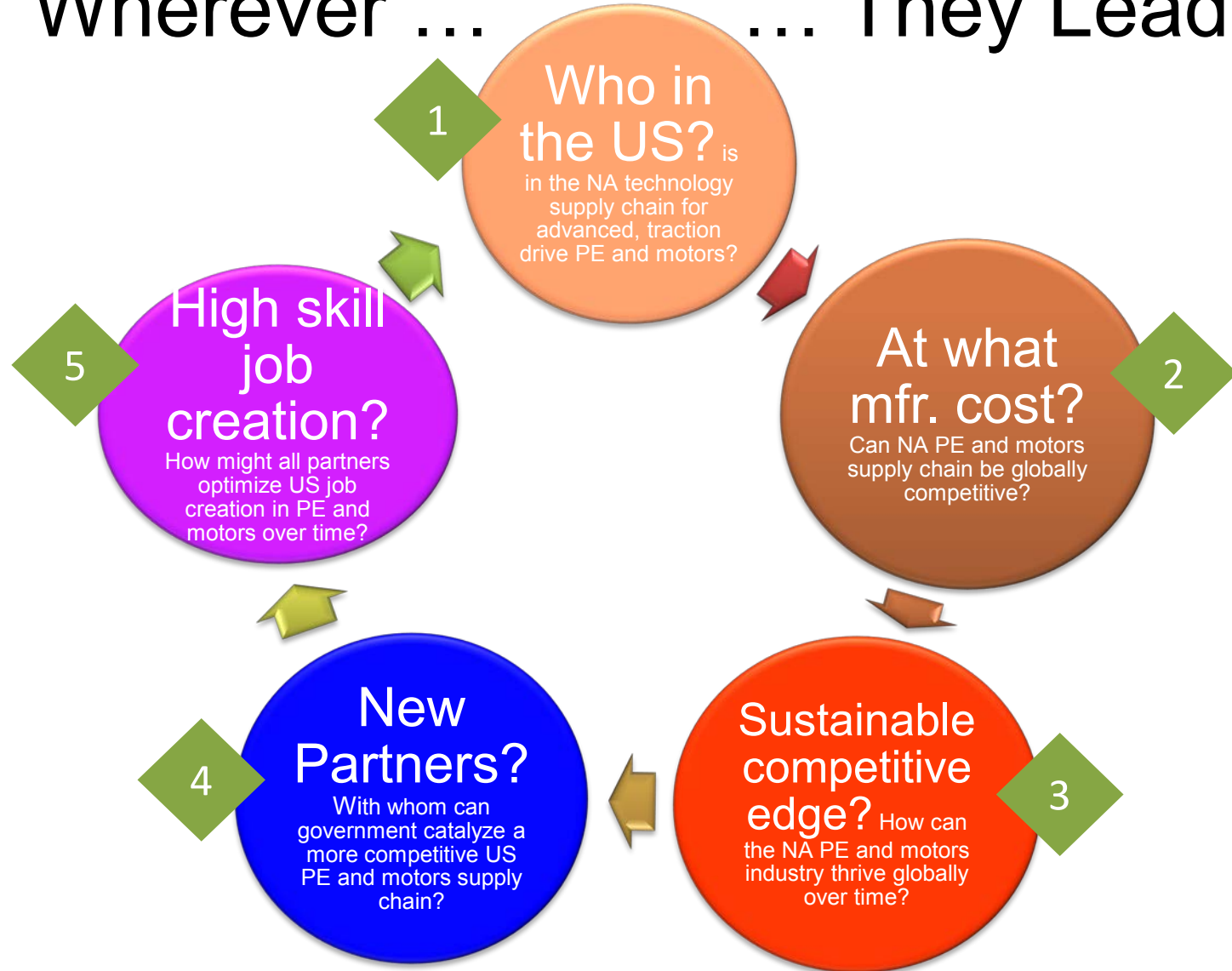
Approach/Strategy:

Produce Custom Findings By Integrating Public Data and Anonymized Private Data

- Private data employed:
 - Synthesis Partners' (SP) three-year-plus interview archive.
 - SP global network of experts.
 - SP network of industry sources (330 companies).
 - SP company-data and market datasets.
 - Commercially available data-bases, extended and refined by SP.
- Public data employed:
 - Company annual reports and public filings.
 - Public market studies and literature.
 - Internet search (English, some Chinese and Japanese).
 - Conferences and seminars.
 - Federal, state and local data-sets.

This work builds on more than a half-decade of relationship building with and among sources in industry, academia and the electric traction drive research community.

Approach/Strategy: Follow the Facts Wherever They Lead



From Whom Do We Seek Input?

Over the years, 100s of in-depth interviews executed, with individuals at all levels, in the following types of organizations:

- Top global automotive OEMs
- 10s of global automotive Tier 1s
- 100s of global automotive and related Tier 2-4s
- Universities and non-profit research organizations
- DOE National Labs (ORNL, NREL, Argonne, PNNL)
- USCAR Electrical and Electronics Tech Team (EETT)
- DOE and other USG executives
- Other experts

Sample for illustration only:

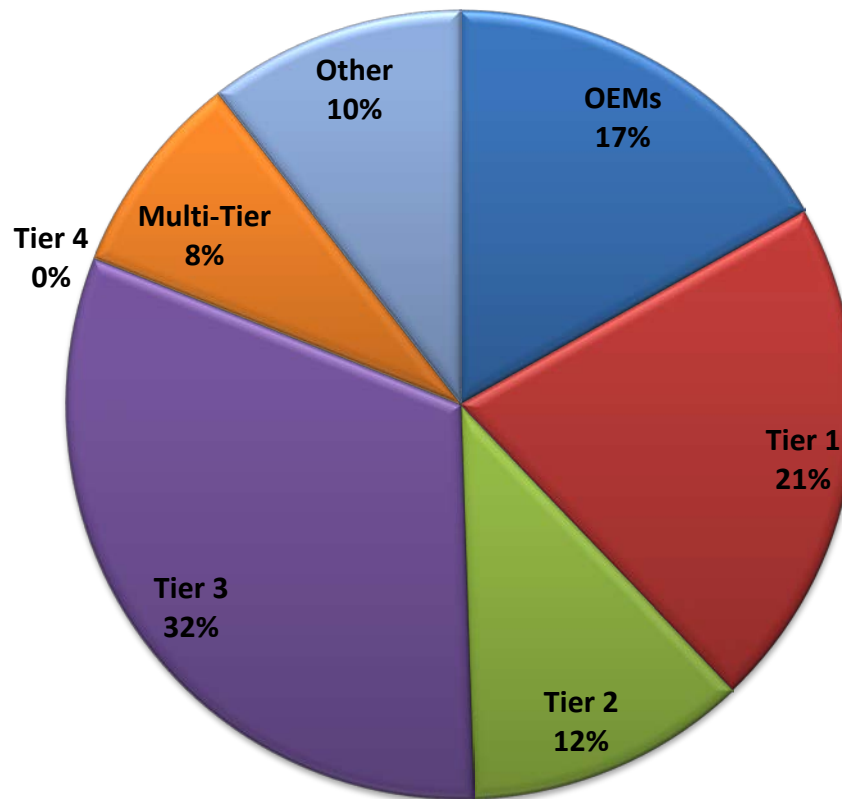


Have we spoken to you? If not, please contact cwhaling@synthesispartners and we will be happy to do so!

Primary Research Contacts

Focus: Traction Drive Motors

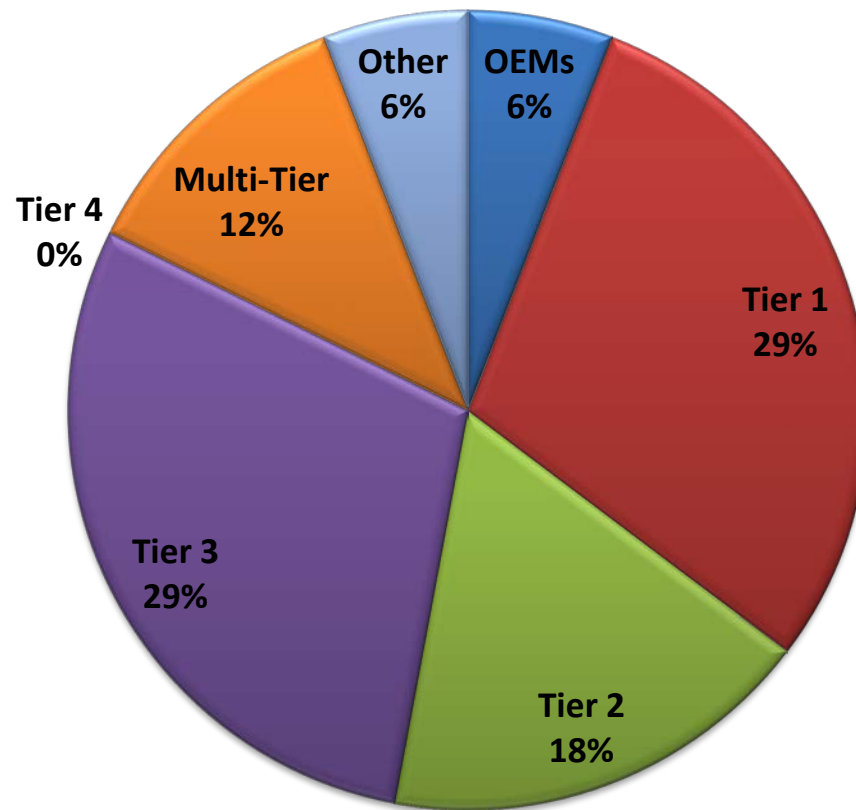
Approximately 100 primary research contacts
made January - April 2015.



Primary Research Interviews

Focus: Traction Drive Motors

Approximately 20 in-depth interviews completed
or scheduled as of mid-April 2015.



Selected, Preliminary, Interview Findings Regarding NA Motors Supply Chain

- Tier 2 - 4 suppliers in "wait and see" mode, waiting on expansion of xEV market and looking to see willingness of OEMs and Tier 1s to engage.
- OEMs and Tier 1s keeping electric motor R&D and manufacturing in-house – and this is unlikely to change until significant expansion of xEV market takes place.
- Lowest cost continues to be major driver for electric motor and components purchases.
- Little evidence yet from OEMs and motor component suppliers of movement to localize R&D and manufacturing activities in USA.

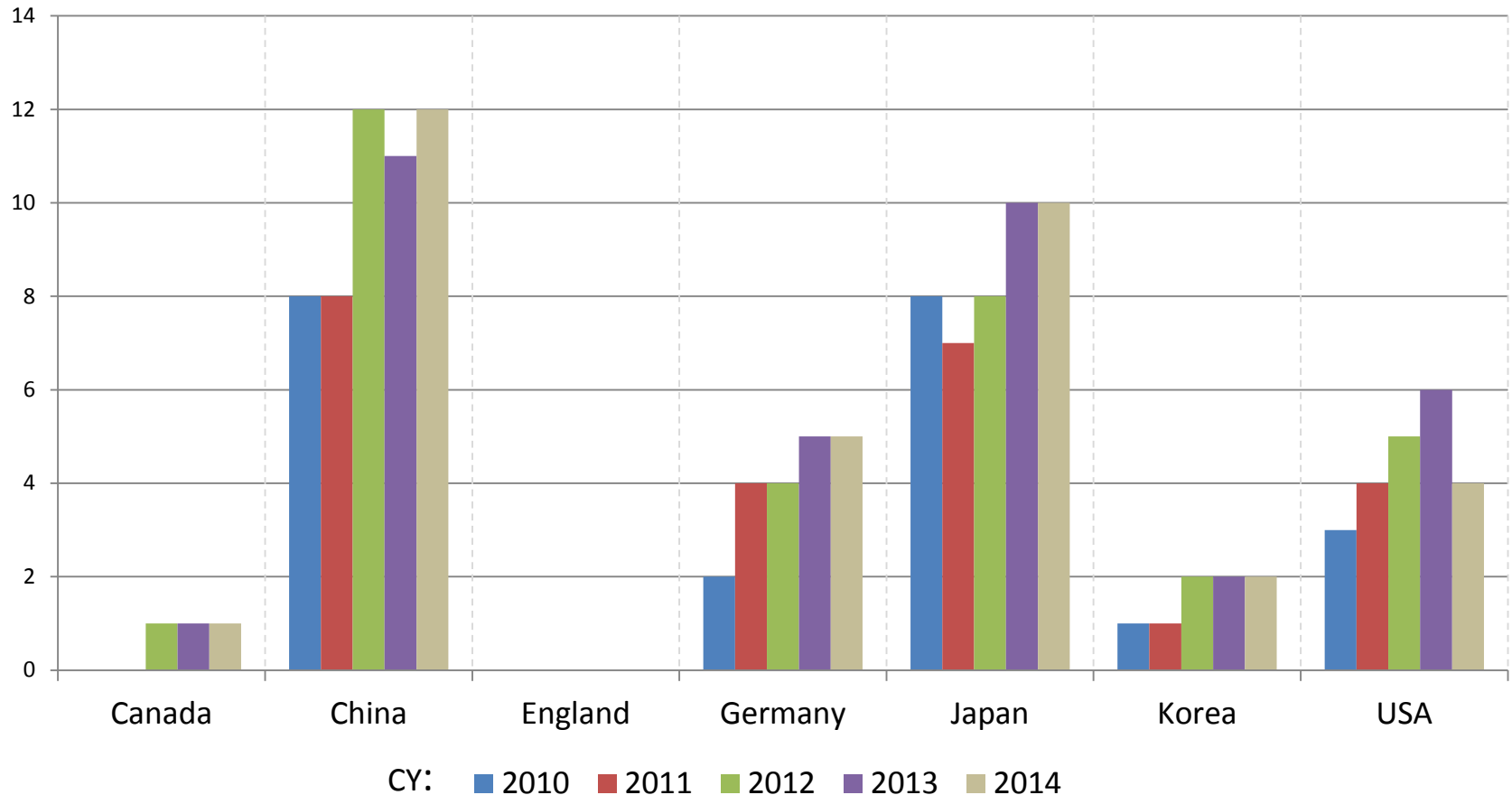
Selected, Preliminary, Interview Findings Regarding NA Motors Supply Chain (cont'd.)

- Hear about the need to maintain and expand motor winding capability in North America.
- New thinking seems to be required on: How to balance increased capacity development, sustainably-competitive, flexible NA manufacturing capability with market needs?
 - Lessons for next-gen materials, motors and PE from ... ?
- Hear a need for \$1-10 million low-cost loan programs for small- to mid-size manufacturers to accelerate innovation in engineering and product development.
- Hear calls for more USG leadership in:
 - Localizing the complete innovation-to-final product food-chain;
 - Educational and program assistance to improve/expand pool of experienced (10 years+) engineers, e.g., product development and embedded software engineering; and
 - Development of standards for electric motors and other xEV technologies.

Global Traction Drive Motors Supply Chain Market Data

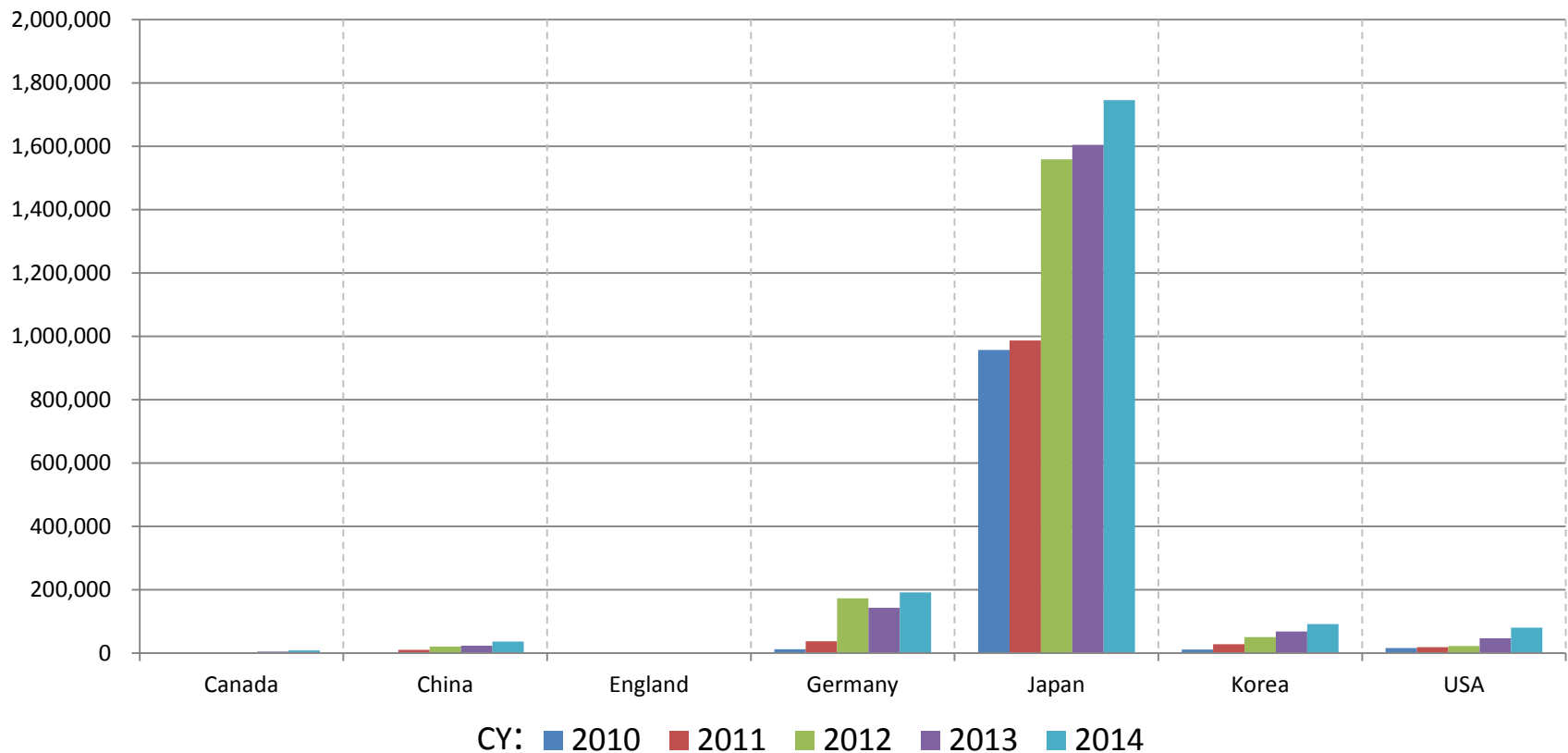
Data through CY 2014.

Number of Companies Supplying Traction Drive Motors to OEMs, by Home Country of Supplier, 2010-2014



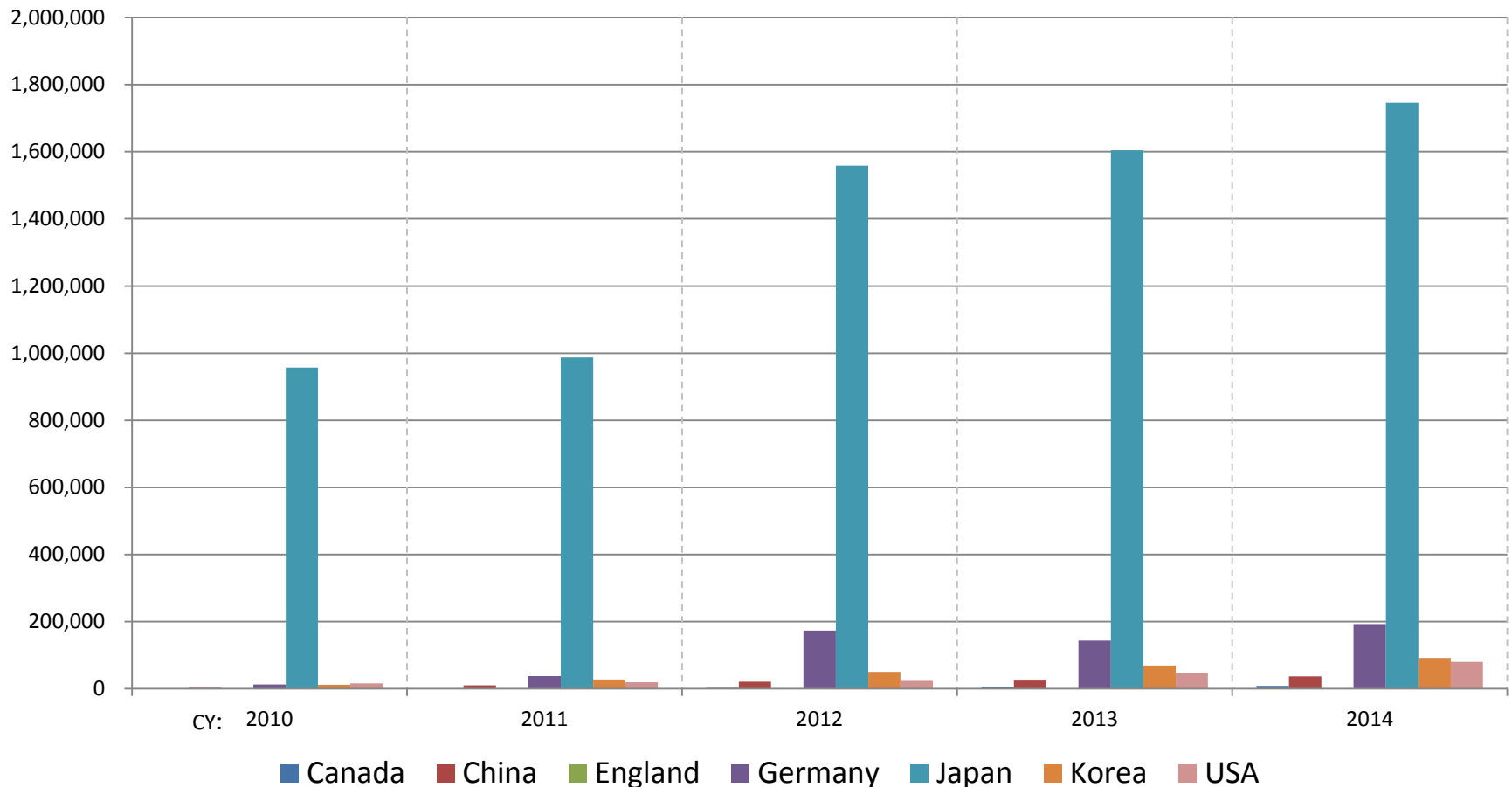
Number of Vehicles with Traction Drive Motors Installed by OEMs, by Home Country of Motor Supplier, 2010-2014

(Rounded to nearest 100).



Number of Vehicles with Traction Drive Motors Installed by OEMs, by Year, by Home Country of Motor Supplier

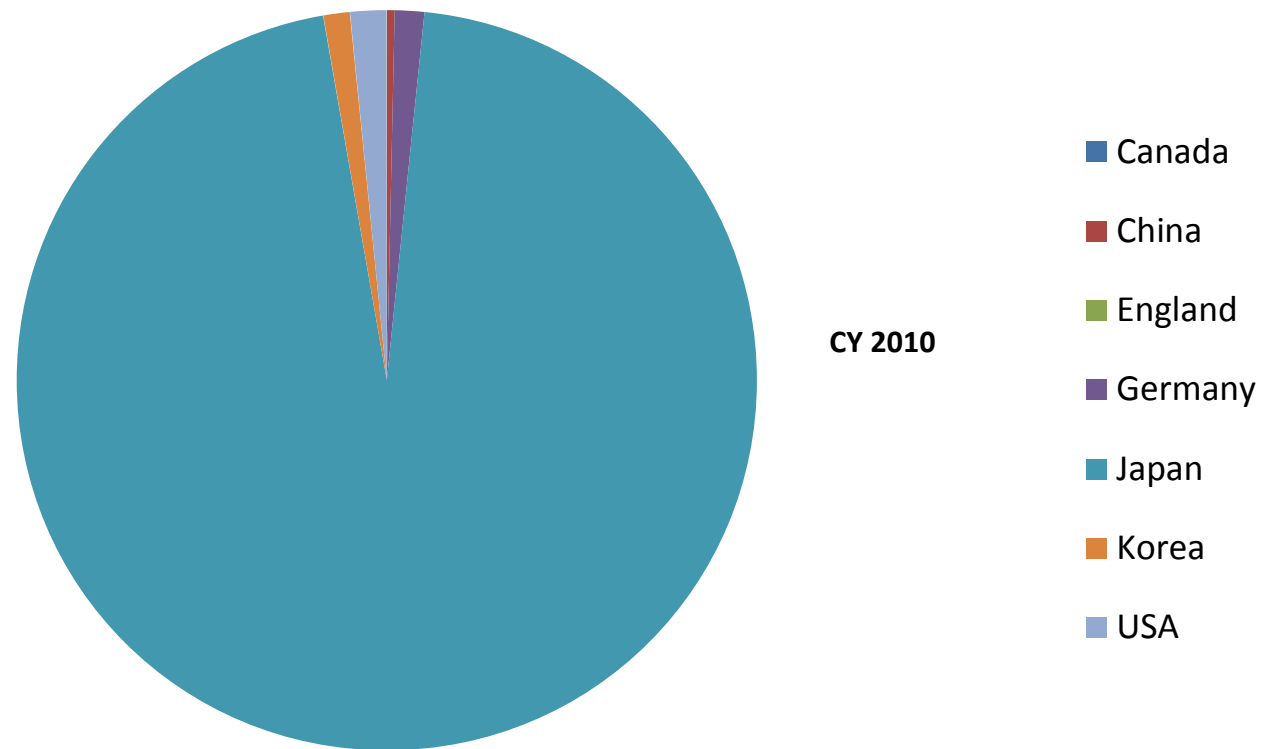
(Rounded to nearest 100)



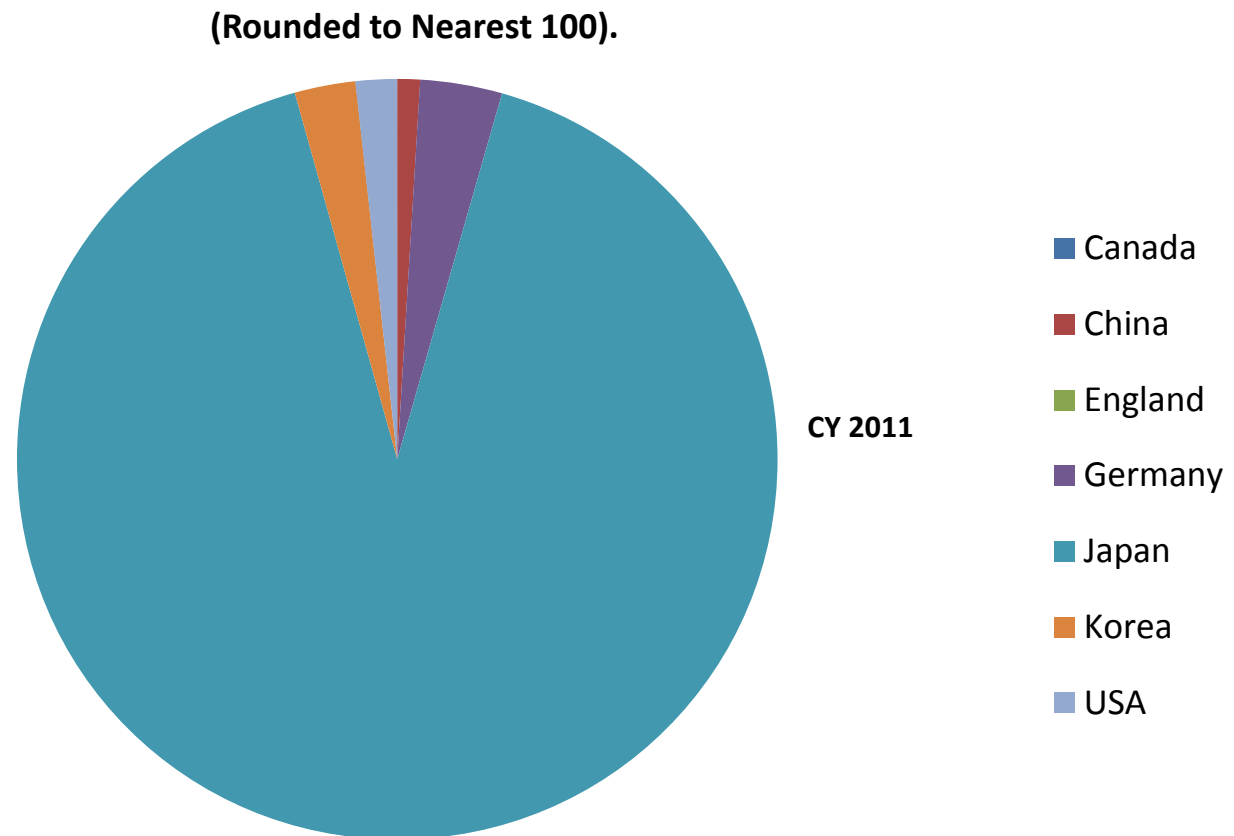
Source: SP Global xEV Database (April 2015) ©.

Number of Vehicles with Traction Drive Motors Installed by OEMs, by Home Country of Motor Supplier, CY 2010

(Rounded to Nearest 100).

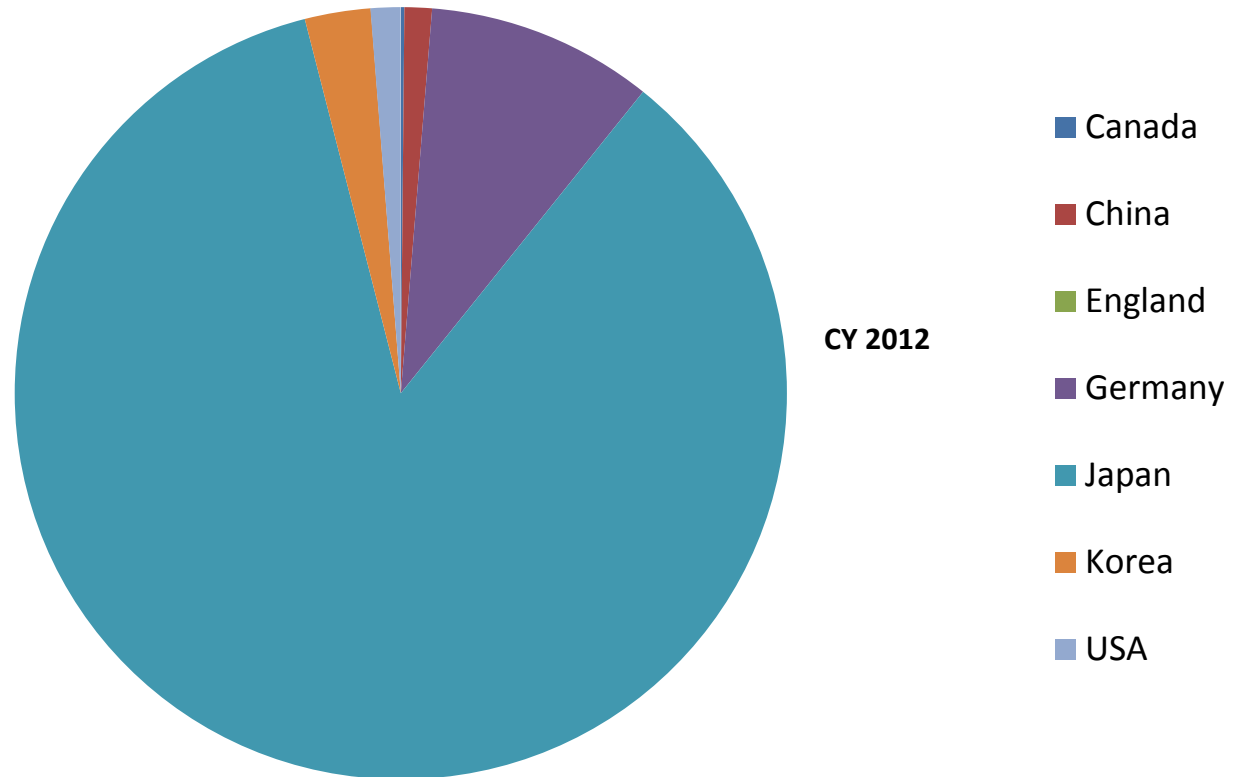


Number of Vehicles with Traction Drive Motors Installed by OEMs, by Home Country of Motor Supplier, CY 2011



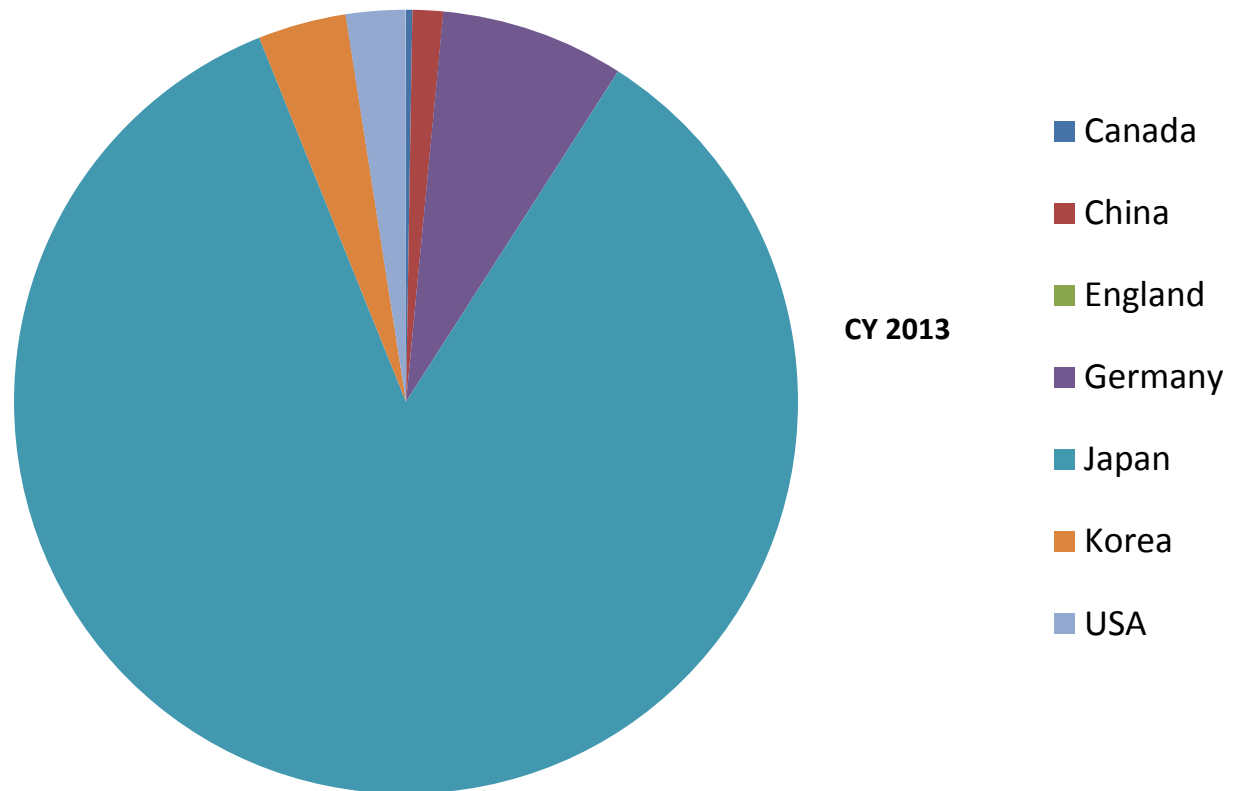
Number of Vehicles with Traction Drive Motors Installed by OEMs, by Home Country of Motor Supplier, CY 2012

(Rounded to Nearest 100)



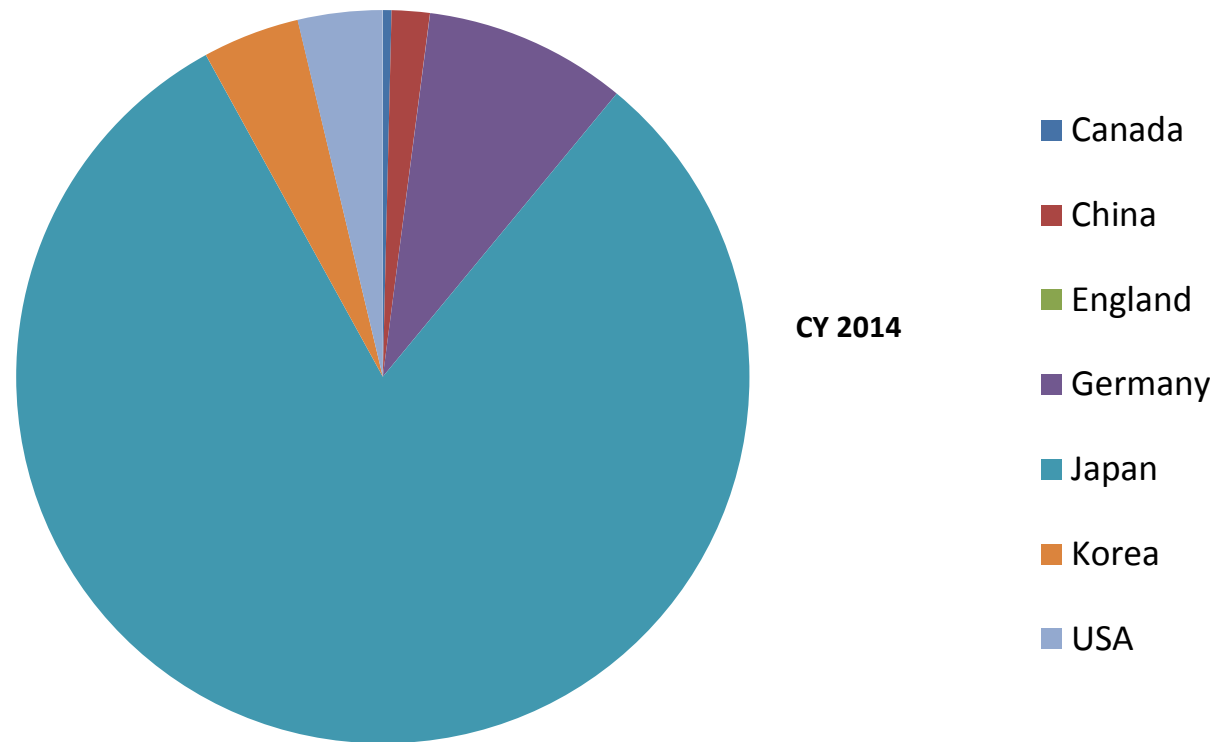
Number of Vehicles with Traction Drive Motors Installed by OEMs, by Home Country of Motor Supplier, CY 2013

(Rounded to Nearest 100)



Number of Vehicles with Traction Drive Motors Installed by OEMs, by Home Country of Motor Supplier, CY 2014

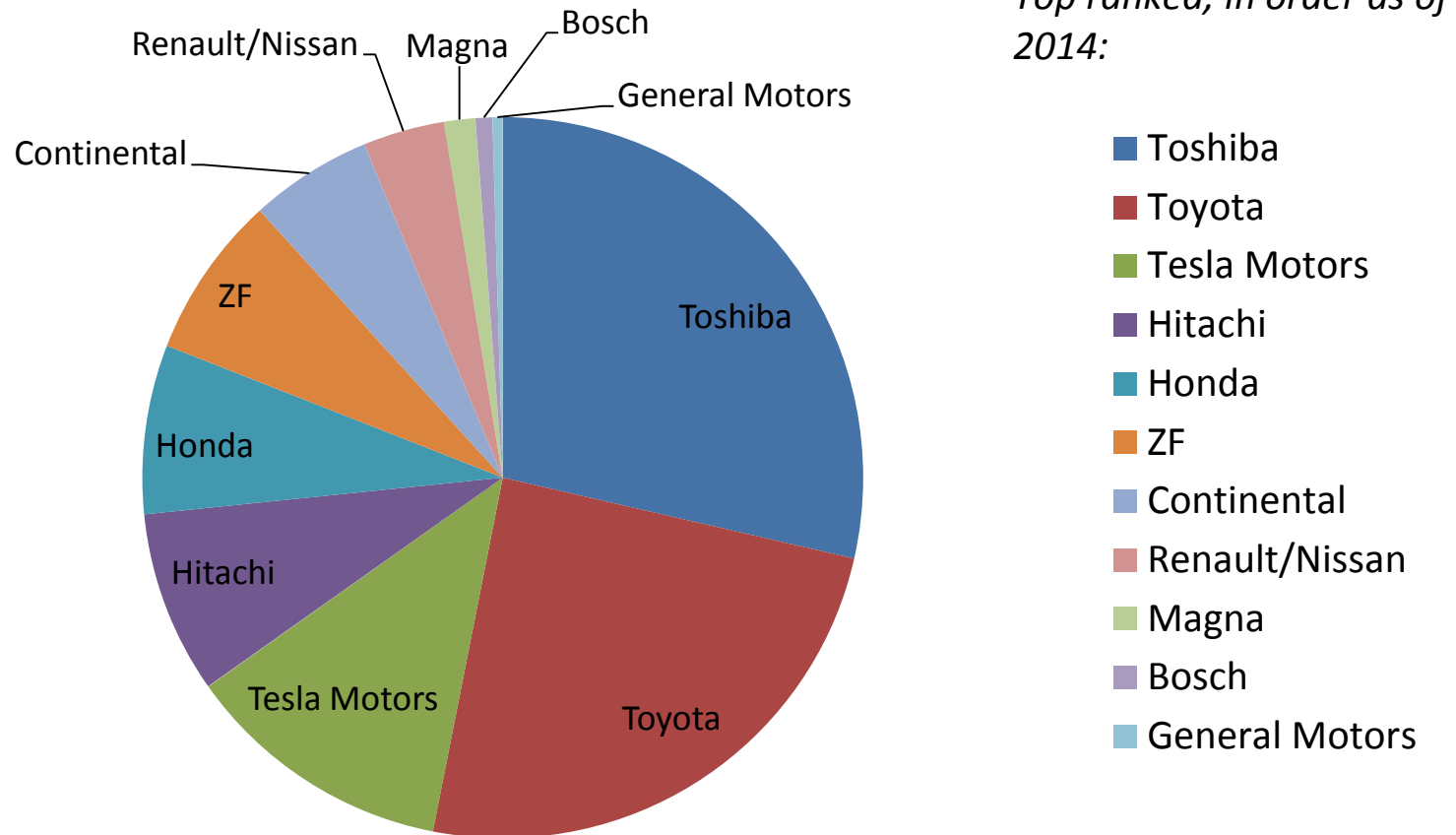
(Rounded to Nearest 100).



Ranking of Suppliers, by Traction Drive Motor Installations for xEVs Sold in the US, and Produced in NA Plants, CY 2014

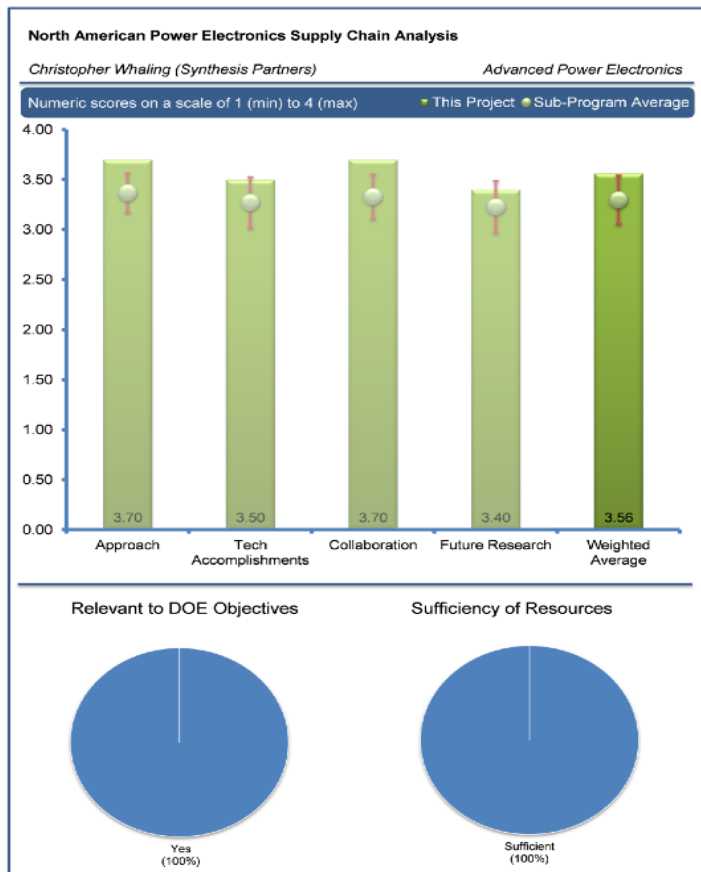
Traction Motor Supplier	Home Country of Supplier	Percentage of xEVs Sold in US with Supplier's Motor	Percentage of xEVs Produced in NA Plants with Supplier's Motor
Toshiba	Japan	14.6%	28.6%
Toyota	Japan	55.0%	24.5%
Tesla Motors	USA	3.2%	12.1%
Hitachi	Japan	3.7%	8.2%
Honda	Japan	4.8%	7.6%
ZF	Germany	0.5%	7.3%
Continental	Germany	1.4%	5.5%
Renault/Nissan	Japan	5.9%	3.7%
Magna	Canada	0.3%	1.4%
Bosch	Germany	1.0%	0.8%
General Motors	USA	0.1%	0.5%
AC Propulsion	USA	1.1%	0.0%
Aisin	Japan	0.1%	0.0%
EM-Motive	Germany	0.8%	0.0%
Fuji Machinery	Japan	1.4%	0.0%
Hyundai Mobis	Korea	6.1%	0.0%
Meidensha	Japan	0.0%	0.0%

Traction Drive Motor Suppliers for xEVs Produced at NA Plants in 2014



FY14 Reviewer Comments and Response

FY14 AMR Review (Five reviewers)



- Good comments received:
 - Multiple reviewers noted that this is a fundamentally collaborative project.
 - Noted trust of sources and understanding “on both sides of the table” critical to success.
- Helpful suggestions received:
 - The project presentation should contain some recent survey conclusions.
 - Response: Agreed – understanding that these findings are preliminary!
 - More details, if possible on future work.
 - Response: New inquiries are always under development, building on open-ended, in-depth conversations with sources. Looking ahead, we are always seeking new thinking on high-impact, collaborative solution development to known challenges in the NA supply chain.

Project Summary

- FY 15 research and analysis work is at mid-point today.
 - Interim findings will be vetted via additional sources and analysis over next six month period.
- FY 15 research builds directly on years of prior work – for DOE-VTO – building source relationships and findings.
 - Great care and responsibility to maintain an increasingly deep pool of researcher, OEM and Tier 1-4 relationships with valuable information that can be used to help address VTO objectives.
 - Critical need to do everything possible to maintain open lines of communication to encourage new thinking, new ideas and a diverse range of actionable information and guidance.
- Collaboration and coordination, including with EETT and VTO stakeholders, is a key ingredient to project success.

Coordination and Collaboration

- Close coordination and involvement with USCAR Electrical/Electronics Tech Team.
- Close coordination and collaboration with industry, OEMs, Tier 1-4, universities, federal laboratories, and subject matter experts on both public and proprietary basis.
- Engagement with domestic and international sources to identify low-cost technology development opportunities in support of VTO goals.
- Federal Research Labs: Targeted information exchange and coordination with ORNL, Argonne, NREL, PNNL and Ames Research Lab.

Thank You!

Q & A discussion.

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